# A COMPARISON OF HERPETOLOGICAL DIVERSITY ACROSS FOREST TYPES IN COSTA RICA

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*Abstract:* Costa Rica is home to a great diversity of amphibians and reptiles. We conducted surveys in four forest habitats with distinct climatic and structural differences: Palo Verde (tropical dry forest), Monteverde (premontane cloud forest), Corcovado (Pacific lowland wet forest), and La Selva (Caribbean lowland wet forest). Amphibian species richness was highest at Palo Verde and La Selva. Amphibian diversity (Shannon Index) was highest at La Selva and relatively low at Monteverde and Corcovado. Although amphibian abundance was highest at Corcovado, only one species of frog was represented there. The low diversity at Monteverde could be partly due to recent amphibian declines (Pounds et al. 1999). Reptilian diversity was high in all sites except Monteverde, and abundances were highest at Corcovado and La Selva. Palo Verde was dominated by large reptilian species such as ctenosaurs and iguanas, while Corcovado and La Selva were composed primarily of smaller species, especially anoles and basilisk lizards. These data provide a baseline for assessments of future changes in the diversity and abundance of Costa Rican herpetofauna.

*Key Words: amphibians, reptiles, species richness*

## INTRODUCTION

Costa Rica is home to an amazing diversity of amphibians and reptiles. Within its borders are 150 amphibian and 220 reptile species, representing 3.33 and 3.67% of the world's species within these classes, respectively. All three classes of amphibians occur in Costa Rica, with three species of caecilians, 35 species of salamanders, and ≈ 120 species of frogs and toads. Costa Rica is also home to all four orders of reptiles, with two species of crocodilians, 14 species of turtles, 68 species of lizards, and 127 species of snakes. This diversity is at least partially due to the wide variety of habitats in the country.

The objective of this study was to examine differences in the abundance and diversity of amphibians and reptiles among four different forest types in Costa Rica: tropical dry forest, sub-montane cloud forest, Pacific lowland wet forest, and Caribbean lowland wet forest. Amphibians and reptiles have been shown to be impacted by an array of habitat disturbances, both worldwide and in Costa Rica (Pounds et al. 1999). The baseline data on amphibian and reptile abundance and diversity provided by this study will aid in the assessment of future habitat change in Costa Rica and of the implications of this change for regional herpetofauna.

Because each of these forests have different climate regimes and physical habitat structures, we expected to see differences in the species composition and abundances of herpetofauna across sites. Amphibian species richness and abundance should be highest in forests with warm, wet climates such as Pacific and Caribbean lowland wet forests. The abundance of riparian habitat should also increase richness and abundance of amphibian species in various forest habitats. In contrast, reptile abundance and diversity may be highest in dry, warm habitats and lowest in the cold and moist habitat of cloud forests.

## METHODS

Amphibians and reptiles were sampled at four sites in Costa Rica during January and February 2000. These sites included Palo Verde National Park (tropical dry forest; 7 - 16 January), Monteverde Forest Preserve (tropical sub-montane cloud forest; 18 - 25 January), Corcovado National Park (Pacific lowland wet forest; 31 January - 8 February), and La Selva Biological Station (Caribbean lowland wet forest; 11 February - 20 February). Qualitative data on species richness were collected by recording all species observed by the 17 - 19 members of our group over the entire stay (approximately one week) at each site. Observations included species identification (or classification to the lowest possible taxonomic group), description, time and date sighted, and cover under which the species was found (rock, leaf litter, etc.). In addition, we conducted quantitative assessments of the amphibian and reptile species richness and abundance from approximately 07:30 to 12:00 on one day at each of the four sites. Shannon-Weiner Diversity Indices were calculated for both reptiles and amphibians at each site.





## RESULTS

Qualitative observations indicated that both amphibian and reptilian species richness were highest at Palo Verde and La Selva (Table 1). Amphibian diversity, measured by the Shannon-Weiner diversity index, was twice as high at La Selva than at Palo Verde and was zero at Monteverde and Corcovado because only a single species was observed at each site during quantitative sampling (Tables 2 - 3). Reptilian diversity was almost two times higher at Palo Verde and Corcovado than at Monteverde (Table 2). Reptilian diversity was consistently higher than amphibian diversity at all four sites (Table 2).

Quantitative sampling indicated that amphibians were more abundant than reptiles at all sites except Monteverde (Fig. 1). Amphibian abundance was highest at Corcovado, though only a single frog species was represented (Figs. 1 - 2). At three of four sites, the most abundant species was a toad or frog (*Bufo* spp. and *Dendrobates pumilio*; Table 2). Reptile abundance was similar at Corcovado and La Selva, but differed in that the most abundant taxon was *Basiliscus basiliscus* and *Norops* spp., respectively (Table 2).

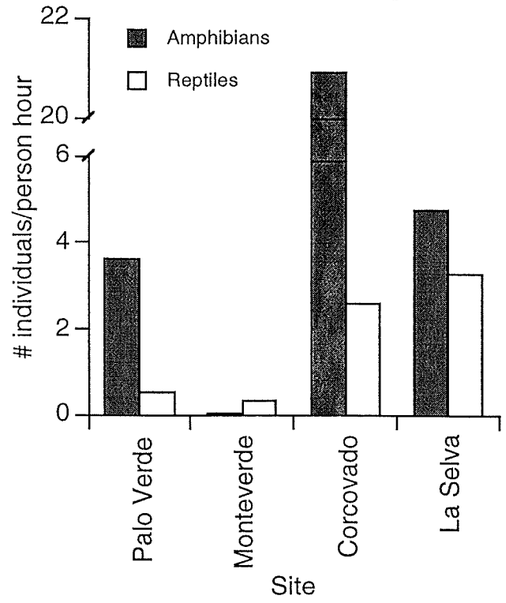


Figure 1. Number of individuals of amphibians and reptiles recorded per person hour across four sites in Costa Rica.

Table 1. Species richness of amphibians and reptiles, average annual temperature (° C) and average annual rainfall (m) across the four sites in Costa Rica.

| Site | Amphibian Richness | Reptile Richness | Temperature (C) | Rainfall (m) |
|---|---|---|---|---|
| Palo Verde | 10 | 22 | 27 | 1.5 |
| Monteverde | 2 | 6 | 19 | 2.5 |
| Corcovado | 6 | 14 | 24 | >4.0 |
| La Selva | 13 | 19 | 24 | 4.0 |

Table 2. Shannon diversity indices for amphibians and reptiles collected during quantitative sampling at four sites in Costa Rica. Abundant species (more than 10 individuals) and number of individuals are listed.

| | H′ Amphibians | H′ Reptiles | Total # Individuals | Abundant species |
|---|---|---|---|---|
| Palo Verde | 0.40 | 1.64 | 93 | *Bufo coccifer* (75) |
| Monteverde | 0.00 | 0.87 | 7 | |
| Corcovado | 0.00 | 1.67 | 619 | Bufo sp. 5 (550), *Basiliscus basiliscus* (23), *Ameiva festiva* (15), *Ameiva undulata* (17) |
| La Selva | 0.84 | 1.10 | 134 | *Dendrobates pumilio* (62), *Norops uniformis* (32), *Norops lemurinus* (10) |

## Discussion

Moisture and temperature explained many patterns in the abundance and diversity of amphibians and reptiles throughout Costa Rica. High amphibian diversity at La Selva is probably due to the rainfall patterns of the Caribbean lowland wet forest as compared with Pacific lowland forest. Unlike Corcovado, which has a defined dry season, rainfall is constant enough at La Selva to maintain many consistently moist habitats. This creates an ideal environment for amphibians because of their strong dependency on moisture, especially for reproduction. Although a dry forest, Palo Verde had a surprising high level of diversity, possibly due to patchy sources of moist habitat within the forest. Amphibians were found concentrated around small streams and the Rio Tempisque marsh. Thus, even though the forest is dry for most of the year, a high diversity is maintained in patchy moist areas throughout the forest and at the edge of the marsh.

The representation of the high amphibian abundance at Corcovado by only one species of frog (550 individuals) suggests that our sampling might have coincided with a seasonal peak in the population following a reproductive pulse of *Bufo* sp. at the end of the wet season. The dry season at Corcovado may impose seasonal limitations on the reproduction of many amphibian species. A shorter reproductive season could limit when amphibians are most visibly abundant, and also limit the number of species that can coexist

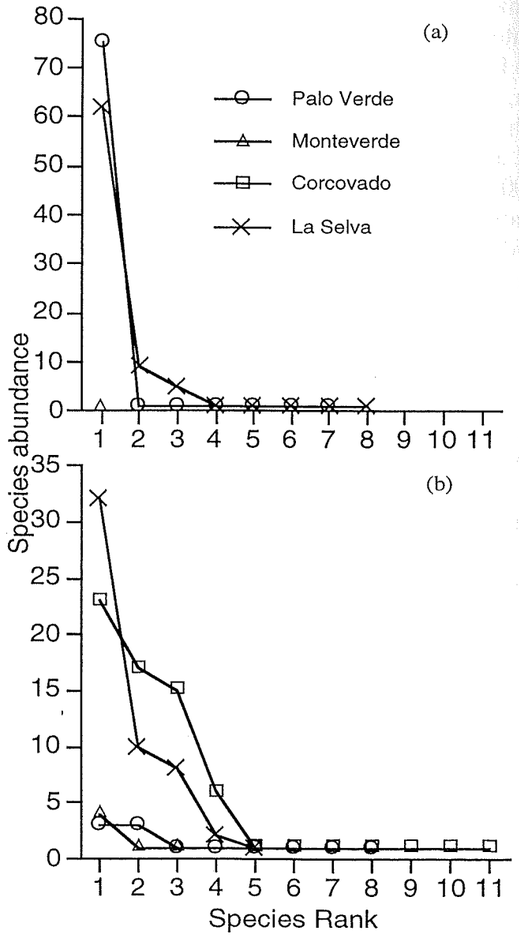


Figure 2. Rank abundance curves of (a) amphibian species and (b) reptile species across four sites in Costa Rica. Abundance of Bufo sp. 5 at Corcovado was excluded in presentation (n = 550).





Table 3: Qualitative species list from four sites in Costa Rica. Unidentified taxa described in Appendix 1.

| Palo Verde | Monteverde | Corcovado | La Selva |
|---|---|---|---|
| Amphibians | | | |
| *Bufo coccifer* | *Bolitoglossa subpalmata* | Bufo sp. 3 | *Bufo marinus* |
| *Bufo marinus* | Leptodactylidae | Bufo sp. 4 | Bufo sp. 6 |
| Bufo sp. 1 | | Bufo sp. 5 | *Cocharella spinosa* |
| Bufo sp. 2 | | Caudata sp. | Cochranella sp. 1 |
| Hyla microcephala | | *Rana taylori* | *Dendrobates pumilio* |
| *Pysalaemus pustulosus* | | Tadpole | Eleutherodacatylidae sp. 1 |
| *Rana pipiens* | | | Eleutherodacatylidae sp. 2 |
| *Rana taylori* | | | *Elutherodactylus cerasinus* |
| Rana sp. 1 | | | Hyla microcephala |
| *Smilisca sordida* | | | Hylidae |
| | | | Rana sp. |
| | | | *Rana taylori* |
| | | | *Smilisca sordida* |
| Reptiles | | | |
| *Boa constrictor* | *Anolis humilis* | *Ameiva festiva* | *Ameiva festiva* |
| *Caimen crocodilus* | *Anolis limifrons* | *Ameiva undulata* | *Boa constrictor* |
| *Coniophanes piceivitus* | *Lampropeltis triangulum* | *Anolis humilis* | *Caimen crocodilus* |
| *Coniophanes piceivittis?* | Micrusus sp. 1 | *Basiliscus basiliscus* | *Coniophames piceivitus* |
| *Conophis lineatus* | *Norops tropidolepis* | *Caiman crocodilus* | *Conophis lineatus* |
| *Crocodylus acutus* | *Sceloporus malachiticus* | Colubridae 1 | *Ctenosaura similis* |
| *Ctenosaura similis* | | Colubridae 2 | *Drymarchon corias* |
| *Ctenosaura similis* | | *Crocodylus acutus* | *Gonatodes albogularis* |
| *Drymarchon corias* | | *Ctenosaura similis* | *Iguana iguana* |
| *Gonatodes albogularis* | | *Iguana iguana* | *Kinosternon scorpiodes* |
| *Iguana iguana* | | *Norops rodriguezii* | Leptodeira sp. 1 |
| *Kinosternon scorpiodes* | | Reptilia | *Leptophis mexicanus* |
| Leptodeira sp. | | Teidae sp. 1 | *Micrurus nigerocinctus* |
| *Leptophis mexicanus* | | Teidae sp. 2 | *Norops capito* |
| *Leptophis mexicanus* | | | *Norops cupreus* |
| *Micrurus nigerocinctus* | | | *Norops lemurinus* |
| *Norops cupreus* | | | *Norops limifrons* |
| Norops sp. 1 | | | *Norops uniformis* |
| Norops sp. 2 | | | *Notrosamis bicolor?* |
| Norops sp. 3 | | | |
| *Notrosamis bicolor?* | | | |
| Scincidae | | | |

because of competitive interactions among immatures. Abundances at La Selva and Palo Verde were only slightly lower than at Corcovado and species richness was higher (Fig. 1, Table 1). The low abundance and diversity of amphibian species at Monteverde must be at least partly due to the effects of low temperatures on their activity and development. Recent amphibian declines at this site must also contribute to the limited number of amphibians that we encountered (Pounds et al. 1999).

The high diversity of reptiles at Palo Verde and La Selva contrasted sharply with the low diversity of reptiles found in Monteverde (Table 2). Monteverde's extremely moist climate combined with its slightly colder temperatures provide a poor

environment for reptiles that need dry environments for egg development and warmth and sunlight to maintain activity. Reptiles must benefit from consistently warmer temperatures at La Selva and Corcovado, although dry, sunny habitats suitable habitat for reproduction may sometimes be limiting for some species, especially at La Selva. Although Palo Verde's dry, warm environment seems ideal for reptilian growth and reproduction, reptile abundance was higher at Corcovado and La Selva. This could be explained by the size of reptiles inhabiting the respective sites. At Corcovado and La Selva, smaller reptiles such as *Basiliscus basiliscus* and anoles (*Norops sp.*) comprised much of the abundance, while many of the reptiles found at Palo Verde were larger species such as iguanas and ctenosaurs. Thus, the number of reptile individuals might not be indicative of the reptile biomass at each site. Understanding factors that influence the diversity and abundance of amphibians and reptiles is fundamental to understanding their role in communities and ecosystems, and essential in managing landscapes to maintain herpetofauna diversity. Amphibians, due to their reliance on water for reproduction, and reptiles, because of their need for particular temperatures and moisture levels, may be good indicators of environmental change.

## Literature Cited

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